An experiment of used palm oil refinery using the value engineering method

By Minto Waluyo

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Abstract. Palm Oil is one of prime materials which very necessary for Indonesia. In the development of palm oil industry the constraint which faced is raw material availability and the economic crisis that attack Indonesia which cause increasing of cost industry so that the salaes price become very expensive . With using alternative raw material namely used palm oil them be made palm oil design to solve this problems. In the designing which comply the consideration of good pal oil planning aspect be use value engineer study. While the criteria parameter of hygienic palm oil which obtained from the questioner area free fatty acid , water content, Iodine number , peroxide number , odor , taste and the color. The research which use value engineer study is throught any phase that is information phase, analyzes phase, creative phase, developent phase and presentation phase. This research began with doing the identification of palm oil demand, continued by methodology development in order to measure oil design. By using creative process could be obtained flow rate position, the amount of adsorbent and the best settling time for palm oil alternative that is in the flow rate 70 ml/sec, 4% of adsorbent and the 70 minute for the settling time with free fatty acid value: 0.299. While the best palm oil alternative are palm oil with free fatty acid value = 0.299, water content = 0.31, Iodine number = 40.08, Peroxide number = 3.72, odor and taste = Normal, the color = Normal. The Evaluation which done by value engineer study generate the value from alternative palm oil is 1.330 and market palm oil 1.392. Thus, can be conclude that the value engineer study can be good implemented in the alternative palm oil planning so that alternative palm oil can be produced largely because they have better value that market palm oil and appropriate for little industries.

1. Introduction

Cooking Oil constitutes one of the main ingredients whose presence is strongly influenced by the people of Indonesia. The process of cooking oil production is faced with many constraints, one of which being the provision of palm oil . Palm oil which derives from oil palm requires a vast area of agricultural land; however, more and more agricultural land is acquired to be residential areas. Additionally , as complained by the producers , the soaring production costs lead to rocketing prices of cooking oil. As a result , people's purchasing power plummets, especially among food vendors. Against the above backdrop , the present study proposed a solution to the above problem entitled " An Experiment Of Used Palm Oil Refinery Using the value engineering method " It made use of used cooking oil as an alternative to overcoming the problem. Evaluation of the Experiment by using the value engineering method would generate value and performance of the design of alternative cooking oil to be compared with the value and performance of the cooking oil in the market. The researcher inferred that the value engineering method could be implemented properly.

2. Method

The present study used the value engineering method, which is a systematic technique or management to obtain the highest value from the best consideration of cost and performance for a product or project using the engineering principles. The value engineering job plan consists of five (5) stages :Information stage : 2. Creation stage, 3. Analyzes phase , 4. Development stage, 5. Presentation stage. Data were collected from primary data deriving from performing an experiment in the laboratory and secondary data from literature regarding small industries related to the object of the study.

3. Results and Discussion

Information Phase : Primary data were collected by distributing questionnaires to a total of 20 expert respondents of regarding the parametric criteria of hygienic cooking oil which were subsequently calculated by the AHP analysis.*(L. saaty 1996).*

The parametric criteria of hygienic cooking oil include fatty acid content, water content, Iodine number, peroxide number, odor and taste, color. Analysis of cooking oil weighted design criteria

1. Calculating the paired comparison matrix : conducting a paired comparison of each parameter , for example , a comparison of parameter A to parameter B indicates the comparison X condition, otherwise a comparison of parameter B to parameter A indicates the comparison 1/X condition.

Table 1. A paired comparison matrix

Parametric	Free fatty Acid	Water content	Iodine number	Peroxide number	Odor & taste	Color
Free fatty Acid	1.0000	2.0660	2.0280	1.6338	1.6180	2.0699
Water content	0.4794	1.0000	0.8960	0.6672	0.6470	0.8129
Iodine number	0.4932	1.1170	1.0000	0.7189	0.8890	0.9466
Peroxide number	0.6121	1.5010	1.3910	1.0000	1.1210	1.4269
Odor & taste	0.6179	1.5460	1.1250	0.8921	1.0000	1.4633
Color	0.4831	1.2300	1.0560	0.7008	0.6830	1.0000
	3.6857	8.4800	7.4960	5.6189	5.9580	7.7195

2. Calculation Eugen vectors : The elements of the comparison matrix on each row are multiplied to each other in order to obtain nth roots (the number of parameters) . The results other of calculation are a matrix in column I , while Eugenvektors are the results of the division of matrix in column I by the number of column elements of the column matrix.

Table 2. Calculating Eugenvektors

Matrix Column I	Eugen Vektors
1.6881	0.2700
0.7729	0.1166
0.8325	0.1331
1.126	0.1802
1.0580	0.1692
0.8185	0.1309
6.2531	1.0000

The Eugen vectors indicates the weight of each of the parametric criteria of ideal cooking oil.

3. Calculating Eugen Values : The comparison matrix is multiplied by the Eugen Vektors matrix to obtain the column matrix II. Eugen values are the result of division of the column matrix II by Eugen vectors matrix.

Table 3. Matrix Column II and Eugen Values

Matrix Column II	Eugen Vektors	Eugen Values
3.6857	0.2700	0.9951
8.4800	0.1166	0.9887
7.4960	0.1331	0.9977
5.6118	0.1802	1.0112
5.9580	0.1692	1.0080
7.7195	0.1309	1.0104
	55 = maks	6.0116

4. Checking Data Consistency : The consistency index (CI) indicates the amount of deviation from consistency when performing the paired comparion.

$$CI = \frac{(\text{maks} - n)}{(n - 1)}$$

$$CI = \frac{(6.0116 - 6)}{5} = 0.0023$$

Data are considered consistent when the consistency ratio (CR) is < 0.10

CR = CI / RI ____> CR = 0.0023 / 1.24

CR = 0.0019 (consistent)

Creation Phase: The set of cooking oil alternative designs was varied in terms of mixture of adsorbent concentrations, settling time and the flow rate of oil and subsequently analyzed for acid levels. The effects of flow rate on acid levels in variables of addition of adsorbent concentration and settling time :

- Adsorbent concentration (%) = 2,3,4,5,6
- Settling time (minutes) = 50,55,60,65,70
- Flow rate (ml/minutes) = 70

The best design is based on a combination of adsorbent concentration and settling time for acid levels (%).

Table. 4. Result of Arrangement Of Alternative Designs

NO	Adsorbent Concentrations(%)	Settling Time (menit)	Acid levels (%)
1	2	60	0.333
2	3	55	0.315
3	4	70	0.299
4	5	60	0.351
5	6	55	0.333

The technical analysis of the 5 alternative cooking oil designs was conduted by experiments with regard to parametrix criteria of cooking oil. The results are shown in table.5.

Table 5. Alternative Cooking Oil Designs

Parametrix	Alternative I	Alternative II	Alternative III	Alternative IV	Alternative V
Free fatty acid	0.333	0.315	0.315	0.333	0.299
Water content	0.470	0,390	0.420	0.340	0.310
Iodine numberI.	42.370	43.250	40.210	39.970	40.080
Peroxide number	3.650	4.210	3.980	3.820	3.720
Odor & taste	Normal	Normal	Normal	Normal	Normal
Color	Normal	Normal	Normal	Normal	Normal

Analysis Phase : The performance of the cooking oil alternative designs was calculated by multiplying the weight of each criterion by the performance of each criterion.
Performance (P) of main function

Main P = (b1 x P1) + (b2 x P2)
= (0.270 x 1.091) + (0.116X 4.492)
= (0.295 + 0.524) = 0.819

The performance of the components of other cooking oil alternatives was calculated in the same way.
Performance evaluation of cooking oil alternatives :

Performance of Alternative I = 0.8190
Alternative II = 0.9724
Alternative III = 0.6046
Alternative IV = 1.7480
Alternative V = 4.4607-----→ the selected alternative cooking oil

The Performance of cooking oil in the market = 4.5624
Development Phase : The cooking oil alternative designs were selected on the basis of cooking oil alternative values using the formula :

$$\text{VALUE} = \frac{\text{PERFORMANCE}}{\text{COST}}$$

= 4.4067 / 3353 = 1.330

The value of the cooking oil in the market was 1.392 market. Thus , the value of the alternative cooking oil nearly approaches the of the cooking oil in the market. *In other words , it is edible.*
Presentation Stage : The final results of the study indicated that the value of the alternative cooking oil is comparable to that of cooking oil in the market . Hence, the present study is feasible.

4. Conclusion

a) A combination of an adsorbent concentration of 4%, a settling time of 70 minutes and a flow rate of 70 ml/min produced a cooking oil alternative design with the following parameter ie criteria : free fatty acid content of 0.229, water content of 3 .10, Iodine value of 40.080 , Peroxide value of 3.720, Odor & taste : normal , Color : normal.

b) The value of the alternative cooking oil with the greatest performance was 1.330 while that of the cooking oil in the market was 1.392.

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